Final Exam for FE511

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I pledge my honor that I have abided by the Stevens Honor System.

Question 1 Part 1

```
bond <- function(y){
  value <- 5 * exp(-0.5*y) + 5 * exp(-1*y) +
    5 * exp(-1.5 * y) + 105 * exp(-2*y) - 109.28
  return(value)
}

dbond <- function(y){
  value <- -2.5 * exp(-0.5*y) + -5 * exp(-1*y) +
    -7.5 * exp(-1.5 * y) + -210 * exp(-2*y)
  return(value)
}

y0 = 0.02
while(1){
  y1 <- y0-bond(y0) / dbond(y0)
  if(abs(y0-y1)<1e-5)
  {
    print("The interest rate is")
    cat("r = ", y1, sep = "")
    break
  }
  y0 <- y1
}
```

Part 2

```
library(quantmod)
AAPL.traning <- getSymbols("AAPL", from = "2015-11-26", to = "2017-11-26", auto.assign = F)
AAPL <- data.frame(AAPL.traning)
aapl.rtn <- diff(log(AAPL$AAPL.Adjusted))
realized.var <- sum(aapl.rtn^2)/length(aapl.rtn)
realized.vol <- sqrt(realized.var) * sqrt(252)
realized.vol
```

Part 3

```
AAPL.traning <- data.frame(AAPL.traning)
St <- AAPL.traning$AAPL.Close[length(AAPL.traning$AAPL.Close)]
AAPL.testing <- getSymbols("AAPL", from = "2017-11-26", to = "2018-11-26", auto.assign = F)
AAPL.testing <- data.frame(AAPL.testing)

Maturity <- 1
steps <- length(AAPL.testing$AAPL.Close)
S0 <- St
path <- 5000
r <- 0.05
```

```
sigma <- realized.vol


result1 <- replicate(steps,0)
ST1 <- NULL
set.seed(10443234)
for (i in 1:path){
  dt <- Maturity / steps
  epsilon.t.vec <- rnorm(steps)
  dwt.vec <- epsilon.t.vec * sqrt(dt)
  St.vec <- c()
  St.vec[1] <- S0
  for(i in 1:steps){
    St.vec[i+1] <- St.vec[i] + r * St.vec[i] * dt + sigma * St.vec[i] * dwt.vec[i]
    result1[i] <- result1[i] + St.vec[i]
  }
  ST1 <- c(ST1, St.vec[steps])
}
result1 <- result1 / path


result2 <- replicate(steps,0)
ST2 <- NULL
set.seed(10443234)
for (i in 1:path){
  dt <- Maturity / steps
  epsilon.t.vec <- rnorm(steps)
  dwt.vec <- epsilon.t.vec * sqrt(dt)
  St.vec <- c()
  St.vec[1] <- S0
  for(i in 1:steps){
    St.vec[i+1] <- St.vec[i] + (0.5 + r * St.vec[i]) * dt + sigma * (St.vec[i] ** 0.9) * dwt.vec[i]
    result2[i] <- result2[i] + St.vec[i]
  }
  ST2 <- c(ST2, St.vec[steps])
}
result2 <- result2 / path

testing <- AAPL.testing$AAPL.Close
library(Metrics)
rmse(testing, result1)
rmse(testing, result2)

# Model2 has less rmse, which is more accurate
# Using ST2 as sample data

price <- testing[length(testing)]
count <- 0
for(i in ST2){
  if(i > price) count <- count + 1
}
count / length(ST2)
```

Model2 has less rmse, which is more accurate Using ST2 as sample data

Bonus

```r
library(ggplot2)
timeline <-  seq(from=as.POSIXct("2017-11-26"),
                 to=as.POSIXct("2018-11-26"),
                 by=60*60*24*366/251)

price <- result2
priceline <- testing
table1 <- data.frame(timeline, price)
table2 <- data.frame(timeline, priceline)
p <- ggplot() + geom_line(data = table1, aes(x = timeline, y = price, col = "Stimulated price"))
p + geom_line(data = table2, aes(x = timeline, y = priceline, col = "Real price"))
```